Dredging Research

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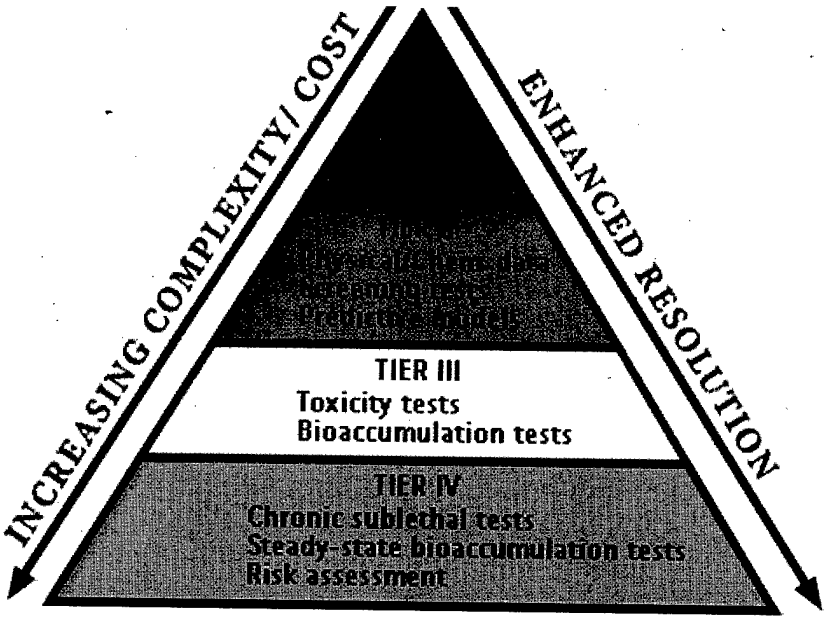
Sediment quality guidelines: An approach to dredged material management Part 1, Aquatic environments

edited by Elke Briuer, APR

Dredged material managers frequently face decisions concerning the impact of contaminated dredged sediment proposed for disposal. One of the first decisions to be made is answering the question: How should the various methods available for evaluating sediment contaminant concentrations be used?

Scientists performing research at the U.S. Army Corps of Engineers Center for Contaminated Sediments have summarized information that helps to select an appropriate method to differentiate sediments of little concern from those predicted to be contaminated sufficiently to warrant special management or handling. The work resulted in Technical Note EEDP-04-29, available online in portable document format (.pdf) at *www.wes.army.mil/el/dots/eedptn.html*, which provides guidance on the use of SQG's (see box next page) for dredged material evaluations. Dr. Richard (Dick) K. Peddicord is the lead author of the 14-page technical note. It includes SQG information for aquatic and terrestrial environments. Funding was provided under the Long Term Effects of Dredging Operations (LEDO) research program.



Described are technical limitations for Tier 1 or Tier 2 screening of sediments that pose little concern under specific circumstances, as well as identifying situations when higher tier, effects-based testing may be used to assess sediment acceptability for a range of disposal options. Limitations make SQGs by themselves technically unacceptable for making definitive determinations of adverse impacts of sediment to the aquatic environment. SQGs are therefore recommended as a screening tool. Case-specific, direct biological effects testing provides a more comprehensive

In this issue . . .

What are SQGs?

The environmental quality of sediments has been judged by chemical concentration values for more than 30 years. Early on, values were derived primarily on the basis of geochemical considerations or sewage discharge values that bore little relevance to dredged material assessment. Approximately 25 years ago, scientists began to develop methods for deriving values associated with adverse biological effects. All past efforts were applied with little success because the methods did not account for the complex biogeochemical interaction of chemicals and sediments. Since then, several methods to determine sediment contaminant concentration values that differentiate sediments of little concern from those predicted to have adverse biological effects have been published. All values used to determine sediment contaminant concentrations that differentiate sediments of little concern from those predicted to have adverse biological effects are collectively called "sediment quality guidelines" even though they have different names. The term SQG was selected because it has broad and general meaning and has no regulatory connotation as a "pass/fail" criterion or standard. The term SQG is broad enough to encompass all the methods leading to sediment quality guidelines, criteria, etc., which are presented in the article.

and technically sound basis for determining the acceptability of sediments for aquatic placement..

The EPA once proposed a technical basis for developing sediment quality criteria. But this and other methods have received varying degrees of attention from the scientific and regulatory communities and citizen groups. Opinions on the utility of SQGs range from essentially worthless to stand-alone, pass-fail determinants of the environmental acceptability of sediments for aquatic placement, according to information presented in the technical note. SQG utility for aquatic environments can be summarized as follows.

Aquatic environments

Mechanistic derivation methods calculate SQG values based on theoretical considerations that relate contaminant concentrations to biological responses. Such methods provide at least a theoretical basis for assuming some cause-and-effect relationship between a contaminant of interest and a biological response. The technical note describes the EPA's

- Equilibrium Partitioning (EqP) sediment guideline, where water partitioning of organics is used to predict contaminant concentrations below which effects are not expected.
- A comparison of this guideline to acid volatile sulfides/simultaneously extracted metals (AVS/SEM). This method uses water partitioning of metals to predict concentrations. Differences between the two methods are also addressed.

Co-occurrence derivation methods statistically calculate SQG values based on contaminant presence in a sediment which resulted in an observed biological response. They include:

- Apparent Effects Threshold (AET), a method of numerically relating sediment toxicity or biological community parameters to sediment contaminant concentrations. An AET is the sediment contaminant concentration above which the biological response of concern occurred in all samples in the data set.
- Effects range low and effects range medium (ERL/ERM), a method for correlating sediment chemical concentrations with biological responses. A large data set with AET and EqP values, results of spiked sediment bioassays, and other types of data forms the basis. Effects data are arranged in order of increasing concentration for each chemical.
- Threshold effects level and probable effects level (TEL/PEL), a method similar to the method for deriving ERL/ERM values, but both "effect" and "no effect" data are used in calculating TEL/PEL values. Essentially, the TEL corresponds to the ERL and the PEL to the ERM, with the TEL/PEL values adjusted upward or downward depending on the overlap of the distributions of the "effects" and "no effects" data for each contaminant.

Some limitations are common to all SQGs derived by any of the mechanistic or co-occurrence methods. Such limitations are:

- Chemical-specific SQGs do not address the interaction of chemicals. All SQG derivation methods proposed to date develop values on a single-chemical basis. Contaminated sediments often contain a variety of metallic and organic contaminants, but no SQGs have been developed that identify the potential interactions of two or more chemicals present together in the sediment.
- SQGs do not adequately consider the exposure component of environmental risk. One of the reasons that exceedance of SQGs cannot predict adverse environmental impacts is that SQGs are derived primarily on the basis of effect-related considerations, rather than exposure.
- SQGs developed for one environment have no relevance for other environments. Some regulatory agencies consider dredged material that exceeds SQGs to be unacceptable for placement at an aquatic site, and then press for placement of such material at upland sites. This approach greatly exceeds any legitimate use of SQGs, and is never appropriate.

Limitations of purely mechanistic derivation methods apply to the following SQGs:

- Equilibrium conditions, upon which both the EqP and A VS/SEM methods depend, rarely occur at dredging sites or aquatic dredged material placement sites since harbor, estuary, and nearshore systems are typically dynamic.
- EqP and AVS/SEM methods and values have not been verified under field conditions.
- Lacking such verification, SQGs derived by either method cannot be relied upon to predict unacceptable adverse effects at aquatic dredged material placement sites. Since AVS cannot exist in the presence of oxygen, and aquatic macrofaunal organisms can only exist in the presence of oxygen, AVS/SEM cannot be used to predict sediment toxicity but only the absence of toxicity.

All co-occurrence derivation methods fail to demonstrate cause and effect.

- The AET method produces inconsistent results. In addition, to manage dredged material responsibly and to improve the quality of dredged material in the future, it is essential that management actions address those contaminants with a demonstrated mechanism by which they could cause effects in the particular sediment in question.
- AET values have a high probability of being false.
- ERL/ERM values and TEL/PEL values were derived from data sets including many AET values, and thus are limited in much the same way as AET values.

In spite of appropriate uses of aquatic environment SQG methods that adequately describe the general trend, none can reliably identify individual sediments as biologically adverse. Only case-specific, direct effects tests can determine that an individual contaminated sediment is biologically adverse. Under very specific circumstances, SQGs may be useful as a screen for early identification of sediments of little environmental concern due to contaminants, and those that are potentially contaminated and require additional assessment. SQGs should not be used for any other purposes in dredged material evaluations.

Additional technical information is available from Dr. Robert M. Engler at 601-634-3624. Questions on policy can be directed to Mr. Joseph P. Wilson. (Ed note: Look for Part 2, Terrestrial environments, in the March '99 issue of *Dredging Research*).

Long-Term Effects of Dredging Operations (LEDO) Program

The LEDO Program focuses on cost-effective, environmentally responsible techniques for dredging and dredged material disposal in aquatic, wetland, and upland environments. Current research emphasizes risk-based procedures for effects assessment, exposure assessment, and risk characterization. The Program objective is to provide the latest proven technologies for identifying, quantifying, and managing contaminated sediments in support of cost-effective, environmentally responsible navigation.

The primary benefit is a more timely, complete, and cost-effective execution of the Corps' responsibilities under the Clean Water Act (CWA), Marine Protection, Research, and Sanctuaries Act (MPRSA), Resource Conservation and Recovery Act (RCRA), and Water Resources Development Act (WRDA). This R&D program provides dramatic cost avoidances annually for achieving restoration goals for contaminated dredged material disposal as mandated by law. Recent major products include:

- **A chronic/sublethal and genotoxic assay that meets national regulatory requirements.**
- **National guidance for confined disposal facility contaminant loss assessment procedures. The guidance document was established as Corps policy to meet regulatory mandates.**
- **A new analytical screening method that measures bioavailable dioxin and similar compounds with a 90 percent reduction cost and time required by previous methods (co-sponsored with another research program).**
- **The Environmental Residue Effects Database (ERED), the first WWW-accessible database of bioaccumulation effects to improve the accuracy and defensibility of environmental impact predictions while significantly reducing evaluation costs.**

LEDO research benefits/value-added to district projects can be demonstrated on a recent example. Since the bioaccumulation interpretation database is Web-accessible, it is immediately and cost-effectively available to all district projects in need of contaminated material assessment.

Focus Area — Innovative Technology

visit online *www.wes.army.mil*

Mr. Norman R. Francingues will take over leadership of the Innovative Technology focus area in the DOER program effective Jan. 1999. He moves in as focus area manager from his DOER Advisory Committee position. Currently, Francingues is working with the Norfolk District on an innovative technology in action there, among other available opportunities. The technology, a telescoping weir, was recently featured in *Engineer Update*. This technology will be evaluated under the DOER for potential efficiency and cost savings for Corps dredging projects.

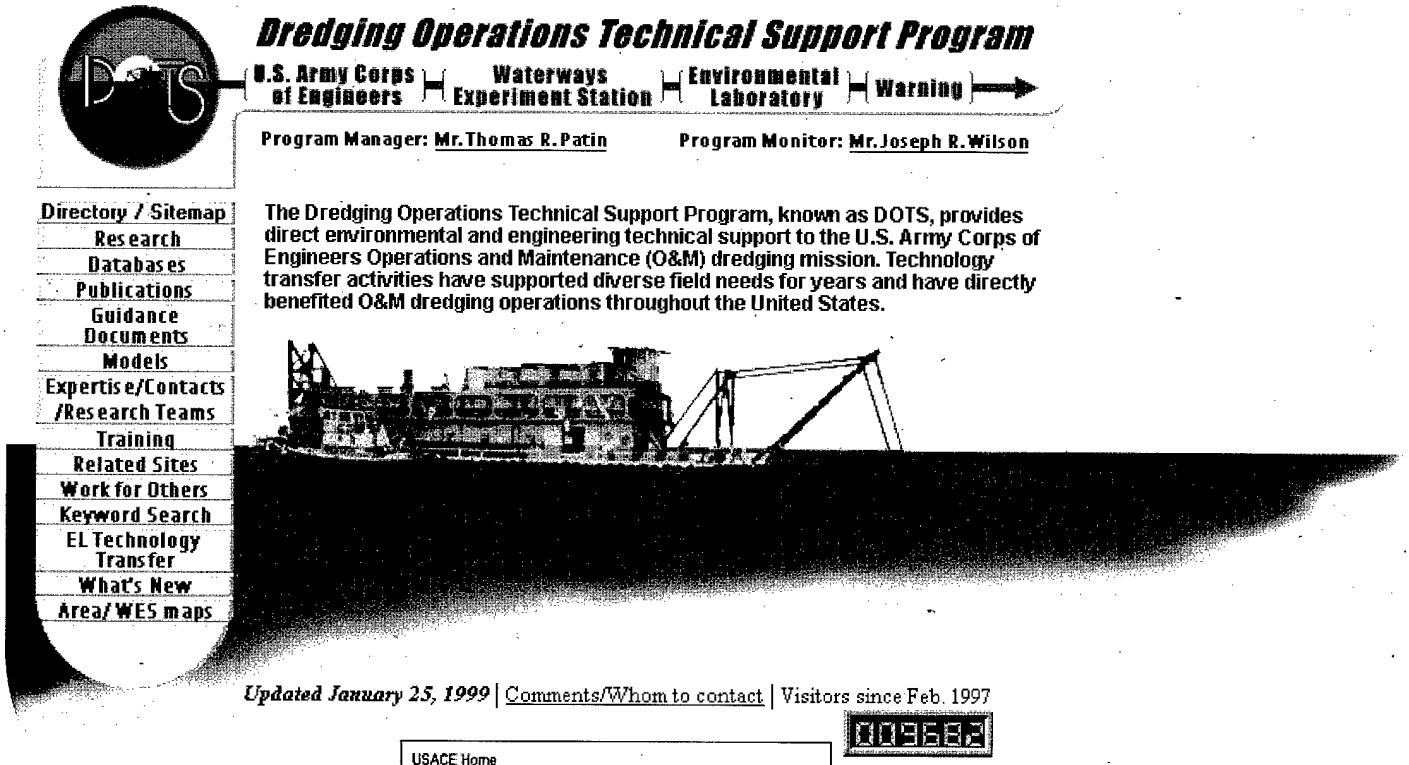
Calendar of Events

Mar 21-25, 1999 217th National Meeting, American Chemical Society, Anaheim, CA
POC: lipnick.robert@epamail.epa.gov

May 15-20, 1999 Western Dredging Association, WEDA XIX, Texas A&M University 31st Annual Dredging Seminar, Louisville, KY
POC: 360-750-0209 or 503-285-5521

Jun 20-24, 1999 Coastal Sediments '99, 4th International Symposium on Coastal Engineering and Science of Coastal Sediment Processes, Long Island, NY
POC: 512-882-2250

Corps dredging research presented on updated DOTS homepage



visit online *www.wes.army.mil/el/dots/*

The new format of the DOTS homepage incorporates some JavaScript. For anyone experiencing long load times, it may be helpful to click the stop button after 30 seconds and then reload, as the mandatory Corps interface box on the bottom of the page sometimes needs a little more time.

Recently required security upgrades for DoD servers have created some problems with the *E2D2* publication reference data base. *E2D2* should be up and accessible to the general public by mid-February, and available to our military audiences by end of January.

Articles for Dredging Research requested

Dredging Research **is an information exchange bulletin for publication of WES generated dredging research results. Included are articles about applied research projects. The bulletin serves all audiences and is accessible on the World Wide Web in addition to a circulation of 2,800.**

Articles from non-WES authors are solicited for publication, especially if the work described is tied to the use of WES generated research results. Research articles that complement WES research or cover wide field applications are also accepted for consideration. Manuscripts should include suggestions for visuals and a brief biography of the author and should use a non-technical writing style. Point of contact is Elke Briuer, APR, at *briuere@mail.wes.army.mil.*

Corps supports coastal engineering education program

The U.S. Army Corps of Engineers recognizes the necessity for maintaining highly qualified coastal engineers to meet present and future challenges in this critical mission area. To meet this need, a unique course of study has been developed for Corps professionals, but the curriculum is equally applicable to individuals working for other governmental agencies and the private sector. All qualified individuals will be considered for admission.

The one-year program is designed to provide students with basic academic coursework and practical training essential for solving modern-day coastal engineering problems. Program graduates will have the fundamental knowledge and tools necessary to meet the coastal engineering challenges of today. The program is offered through the WES Graduate Institute jointly by Texas A&M University (TAMU) and the Corps' Coastal and Hydraulics Laboratory (CHL). A Master of Engineering degree will be awarded by TAMU upon successful completion of the program. Some students may prefer to enroll in the Master of Science (M.S.) degree program, where requirements differ slightly from those of the M.E. degree.

Students will spend the fall semester at TAMU in College Station, TX, and the spring semester at CHL in Vicksburg, MS. This will be followed by a brief field visit to the CHL Field Research Facility (FRF) in Duck, NC, during the period between the spring and summer semesters. The summer semester will be spent at CHL.

For additional information and to receive a comprehensive brochure contact:

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Center for Contaminated Sediments

ADDAMS software to add Windows upgrade

Three ADDAMS software modules currently available in DOS are nearing completion in a Windows version. The new formats will be placed online at *www.wes.army.mil/el/elmodels*.

ADDAMS is a personal-computer-based design, analysis, and evaluation system for dredged material disposal and management. The creation of the system was a response to requests by U.S. Army Corps of Engineers field offices for tools to rapidly evaluate dredged material management alternatives.

ADDAMS is a set of continually evolving, state-of-the-art, computer-based tools that will increase the accuracy, reliability, and cost-effectiveness of dredged material management activities in a timely manner. More specifically, ADDAMS provides necessary tools to perform the engineering and planning evaluation for development of a long-term management strategy for dredged material disposal and to evaluate the environmental acceptability of dredged material management alternatives.

Presently, ADDAMS has programs for 16 applications involving management of dredged material disposal or evaluation of environmental acceptability of dredged material disposal alternatives. ADDAMS also has a demo which gives information for 8 of the programs.

U.S. Army Corps of Engineers Dredging Research Products 1998

Technical Reports

DOER-1, Guidance for Subaqueous Dredged Material Capping, June 1998.

In preparation

DOER-2, Risk Assessment Framework for Management of Dredged Material.
DOER-3, Risk Characterization of Dredged Material.

Technical Notes

Aquatic disposal

EEDP-01-42, Sediment Organic Matter Quality Effects on Pore Water Contaminants, May 1998.

Upland disposal

EEDP-02-24, Volatile Losses from Exposed Sediment, May 1998.
EEDP-02-25, Predicting Surface Runoff Water Quality from Upland Disposal of Contaminated Dredged Material, May 1998.

Regulatory

EEDP-04-29, Use of Sediment Quality Guidelines (SQGs) in Dredged Material Management, May 1998.

Focus area - Contaminated sediments

DOER-C1, Guidance for Performance of the H4IIE Dioxin Screening Assay, February 1998.
DOER-C2, Dredged Material Screening Tests for Beneficial Use Suitability, February 1998.

Focus area - Nearshore/aquatic placement

DOER-N1, LTFATE Cohesive Sediment Transport Model, April 1998.
DOER-N2, DMSMART - Dredged Material Spatial Management, Analysis, and Record Tool, April 1998.
DOER-N3, Planning Considerations for Nearshore Placement of Mixed Dredged Sediments, March 1998.

Focus area - Risk management

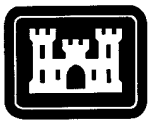
DOER-R1, Dredging/Dredged Material Management Risk Assessment, September 1998.

Focus area - Environmental windows

DOER E-1, Entrainment by Hydraulic Dredges: A Review of Potential Impacts, December 1998.

In preparation

DOER E-2, Environmental Windows Associated with Dredging Operations.
DOER E-3, Economic Impacts of Environmental Windows Associated with Dredging Operations.
DOER E-4, FISHFATE: Population Dynamics Models to Assess Risks of Hydraulic Entrainment by Dredges.
DOER E-5, Evaluation of Techniques for Use in Physical Monitoring of Dredged Material Plumes.



US Army Corps of Engineers

Dredging Research

This bulletin is published in accordance with AR 25-30 as an information dissemination function of the Environmental Laboratory of the Waterways Experiment Station. The publication is part of the technology transfer mission of the Dredging Operations Technical Support (DOTS) Program and includes information about various dredging research areas. Special emphasis will be placed on articles relating to application of research results or technology to specific project needs. The contents of this bulletin are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or the approval of the use of such commercial products. Contributions are solicited from all sources and will be considered for publication. Editor is Elke Briuer, APR, *briuere@mail.wes.army.mil.* Mail correspondence to the Environmental Laboratory, ATTN: DOTS, *Dredging Research*, U.S. Army Engineer Waterways Experiment Station (CEWES-EP-D), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, or call (601) 634-2349. Internet address: *www.wes.army.mil/el/dots.*

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